

PRELIMINARY AMENDMENT

Serial Number: 10/008,367

Filing Date: November 13, 2001

Title: APPARATUS AND METHOD FOR TREATING VENTRICULAR TACHYARRHYTHMIAS

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IN THE CLAIMS

Please cancel claims 1 - 24 without prejudice or disclaimer.

Please add the following new claims:

25. (New) A method, comprising:

sensing atrial events and ventricular events;

determining ventricular interval rates from pairs of consecutively sensed ventricular events in a detection window, the detection window including a predetermined series of the most recent consecutive ventricular events;

comparing each of the ventricular interval rates in the detection window to a lower rate threshold value for each of two or more rate zones;

classifying a ventricular interval rate of the ventricular interval rates as a fast ventricular interval for a rate zone of the two or more rate zones when the ventricular interval rate is equal to or greater than the lower rate threshold value of the rate zone;

declaring the detection window satisfied when a first predetermined percentage of the ventricular interval rates in the detection window are classified as fast ventricular intervals for the rate zone of the two or more rate zones;

starting a first time interval once the detection window is declared satisfied, the first time interval having a duration allowing monitoring and analysis of cardiac rhythms for assessing an origin of the fast ventricular intervals; and

determining whether to inhibit ventricular tachycardia therapy at the end of the first time interval based on the analysis of cardiac rhythms.

26. (New) The method of claim 25, further comprising:

declaring that the detection window remains satisfied when a second predetermined percentage of the ventricular interval rates in the detection window are classified as fast ventricular intervals for the rate zone of the two or more rate zones; and

resetting the first time interval to zero when the detection window fails to remain satisfied during the first time interval.

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27. (New) The method of claim 26, wherein the first predetermined percentage is greater than or equal to 65 percent, and the second predetermined percentage is greater than or equal to 45 percent.
28. (New) The method of claim 25, wherein the analysis of cardiac rhythms includes determining an average atrial rate from the sensed atrial events and determining an average ventricular rate from sensed ventricular events, and further including inhibiting the ventricular tachycardia therapy if the average ventricular rate is not greater than the average atrial rate by at least a bias factor.
29. (New) The method of claim 28, wherein the bias factor is programmable in the range of 5 - 20 beats per minute.
30. (New) The method of claim 25, wherein the analysis of cardiac rhythms includes determining a ventricular rate from sensed ventricular events and determining whether an onset rate is gradual, wherein the onset rate is the rate of transition of a ventricular rate from a slower sinus rate to a tachycardia rate, and the onset rate is gradual when the onset rate is equal to or greater than an onset threshold value, and further including inhibiting the ventricular tachycardia therapy when the onset rate is gradual.
31. (New) The method of claim 30, wherein determining whether the onset rate is gradual includes:
- programming the onset threshold value;
 - determining a pivot point interval, the pivot point interval being a pair of adjacent ventricular intervals which has the largest decrease in value in a series of ventricular intervals occurring before the detection window is declared satisfied;
 - calculating a baseline average ventricular interval value from a predetermined number of ventricular intervals prior to the pivot point interval;
 - determining the difference between the baseline average ventricular interval value

and the pivot point interval;

determining the difference between the baseline average ventricular interval value and each of a series of three ventricular intervals following the pivot point interval; and

declaring that the onset rate is gradual when the value of less than three of any combination of the difference between the baseline average ventricular interval value and the pivot point interval and the difference between the baseline average ventricular interval value and the series of three ventricular intervals following the pivot point interval are equal to or greater than the onset threshold value.

32. (New) The method of claim 25, wherein the analysis of cardiac rhythms includes determining a ventricular rate from sensed ventricular events and determining whether the ventricular rate is unstable, wherein the ventricular rate is unstable when an average variance of ventricular intervals exceeds a stability interval threshold value, and further including inhibiting ventricular tachycardia therapy if the ventricular rate is unstable.

33. (New) The method of claim 32, wherein determining whether the ventricular rate is unstable includes:

programming the stability interval threshold value;

calculating a ventricular interval difference from a series of ventricular intervals of the sensed ventricular events, wherein the series of ventricular intervals includes a current ventricular interval and a previous ventricular interval;

calculating an average ventricular interval difference from the series of ventricular intervals;

determining a variance value, $VAR(n)$, wherein n is an integer which represents a ventricular interval of the series of ventricular intervals, and wherein $VAR(n)$ is determined by an absolute value of a difference between the current ventricular interval and the previous ventricular interval for the series of ventricular intervals;

determining an initial ventricular interval variance value, VAR_{SEED} , wherein the VAR_{SEED} is an average variance value of $VAR(1)$, $VAR(2)$, $VAR(3)$ and $VAR(4)$,

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wherein VAR(1) through VAR(4) occur immediately before the start of the first time interval;

calculating a new average ventricular interval variance after the start of the duration timer from $VAR_{SEED} * Kvar + VAR(5) * (1-Kvar)$, wherein Kvar is equal to 0.875 and VAR(5) is the ventricular interval pair following the start of the first time interval;

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calculating a subsequent average ventricular interval variance, $VAR_{avg}(NEW)$, after VAR(5) using a weighted average formula: $VAR_{avg} = VAR_{avg}(NEW-1) * Kvar + VAR(n) * (1-Kvar)$, wherein Kvar = 0.875 and n is the integer representing the current ventricular interval;

comparing the subsequent average ventricular interval variance to the programmed stability interval threshold value; and

declaring that the ventricular rate is unstable when the subsequent average ventricular interval variance is equal to or greater than the programmed stability interval threshold value.

34. (New) The method of claim 32, wherein the analysis of cardiac rhythms further includes determining an occurrence of atrial fibrillation from the sensed atrial events, and further including inhibiting ventricular tachycardia therapy if the ventricular rate is unstable and atrial fibrillation is occurring.
35. (New) The method of claim 34, wherein determining the occurrence of atrial fibrillation from the sensed atrial events includes identifying an atrial fibrillation when more than a predetermined majority number of a set of sensed atrial intervals is shorter than an atrial fibrillation interval threshold value, and when more than a predetermined quorum number of subsequent sets of sensed atrial intervals remain shorter than the atrial fibrillation interval threshold value.

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36. (New) An implantable cardioverter-defibrillator, comprising:
- an atrial catheter including at least one atrial sensing electrode;
 - a ventricular catheter including at least one ventricular sensing electrode and at least one ventricular defibrillation electrode;
 - sensing circuitry, coupled to the atrial catheter and the ventricular catheter, the sensing circuitry adapted to sense atrial events and ventricular events from the electrodes;
 - therapy delivery circuitry, coupled to the ventricular catheter, the therapy delivery circuitry adapted to apply or inhibit a ventricular tachycardia therapy;
 - control circuitry, coupled to the sensing circuitry and therapy circuitry, the control circuitry adapted to:
 - detect at least one of a ventricular tachycardia and a ventricular fibrillation by analyzing the sensed ventricular events;
 - start a first time interval when the at least one of the ventricular tachycardia and the ventricular fibrillation is detected;
 - analyze the sensed atrial and ventricular events during the first time interval for assessing an origin of the at least one of a ventricular tachycardia and a ventricular fibrillation to determine whether to apply or inhibit the ventricular tachycardia therapy.
- 37 (New) The implantable cardioverter-defibrillator of claim 36, wherein the control circuitry is adapted to:
- detect the at least one of the ventricular tachycardia and the ventricular fibrillation during the first time interval; and
 - reset the first time interval if the at least one of the ventricular tachycardia and the ventricular fibrillation is detected during the first time interval.

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38. (New) The implantable cardioverter-defibrillator of claim 36, wherein the control circuitry is adapted to:
- determine an average atrial rate from the sensed atrial events;
 - determine an average ventricular rate from the sensed ventricular events; and
 - determine whether the average ventricular rate is not greater than the average atrial rate by at least a bias factor.
39. (New) The implantable cardioverter-defibrillator of claim 38, wherein the therapy delivery circuitry is adapted to inhibit the ventricular tachycardia therapy if the average ventricular rate is not greater than the average atrial rate by at least the bias factor.
40. (New) The implantable cardioverter-defibrillator of claim 36, wherein the control circuitry is adapted to determine whether an onset rate is gradual during the first time interval, wherein the onset rate is the rate of transition of a ventricular rate from a slower sinus rate to a tachycardia rate and the onset rate is gradual when the onset rate is equal to or greater than an onset threshold value.
41. (New) The implantable cardioverter-defibrillator of claim 40, wherein the therapy delivery circuitry is adapted to inhibit the ventricular tachycardia therapy when the onset rate is gradual.
42. (New) The implantable cardioverter-defibrillator of claim 36, wherein the control circuitry is adapted to determine whether the ventricular rate is unstable, wherein the ventricular rate is unstable when an average variance of ventricular intervals exceeds a stability interval threshold value.
43. (New) The implantable cardioverter-defibrillator of claim 42, wherein the therapy delivery circuitry is adapted to inhibit the ventricular tachycardia therapy when the ventricular rate is unstable.

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44. (New) The implantable cardioverter-defibrillator of claim 42, wherein the control circuitry is adapted to determine an occurrence of atrial fibrillation from the sensed atrial events.
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cont.* 45. (New) The implantable cardioverter-defibrillator of claim 44, wherein the therapy delivery circuitry is adapted to inhibit the ventricular tachycardia therapy if the ventricular rate is unstable and atrial fibrillation is occurring.
46. (New) A method, comprising:
sensing atrial and ventricular events representative of cardiac rhythms;
detecting at least one of a ventricular tachycardia and a ventricular fibrillation;
analyzing the cardiac rhythms during a first time interval for assessing an origin of the at least one of a ventricular tachycardia and a ventricular fibrillation, the first time interval started when the at least one of a ventricular tachycardia and a ventricular fibrillation is detected; and
delaying or inhibiting a ventricular tachycardia therapy the origin of the at least one of a ventricular tachycardia and a ventricular fibrillation is in an atrium.
47. (New) The method of claim 46, wherein analyzing the cardiac rhythms includes:
determining an average atrial rate from the sensed atrial events and determining an average ventricular rate from sensed ventricular events; and
determining whether the average ventricular rate is not greater than the average atrial rate by at least a bias factor during the first time interval.

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48. (New) The method of claim 46, wherein analyzing the cardiac rhythms includes:
- determining a ventricular rate from sensed ventricular events;
 - determining an onset rate, the onset rate being the rate of transition of a ventricular rate from a slower sinus rate to a tachycardia rate; and
 - determining whether the onset rate is equal to or greater than an onset threshold value.
- 49 (New) The method of claim 46, wherein analyzing the cardiac rhythms includes:
- determining a ventricular rate from sensed ventricular events; and
 - determining whether the ventricular rate is unstable, wherein the ventricular rate is unstable when an average variance of ventricular intervals exceeds a stability interval threshold value.
50. (New) The method of claim 49, wherein analyzing the cardiac rhythms further includes determining an occurrence of atrial fibrillation from the sensed atrial events.
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